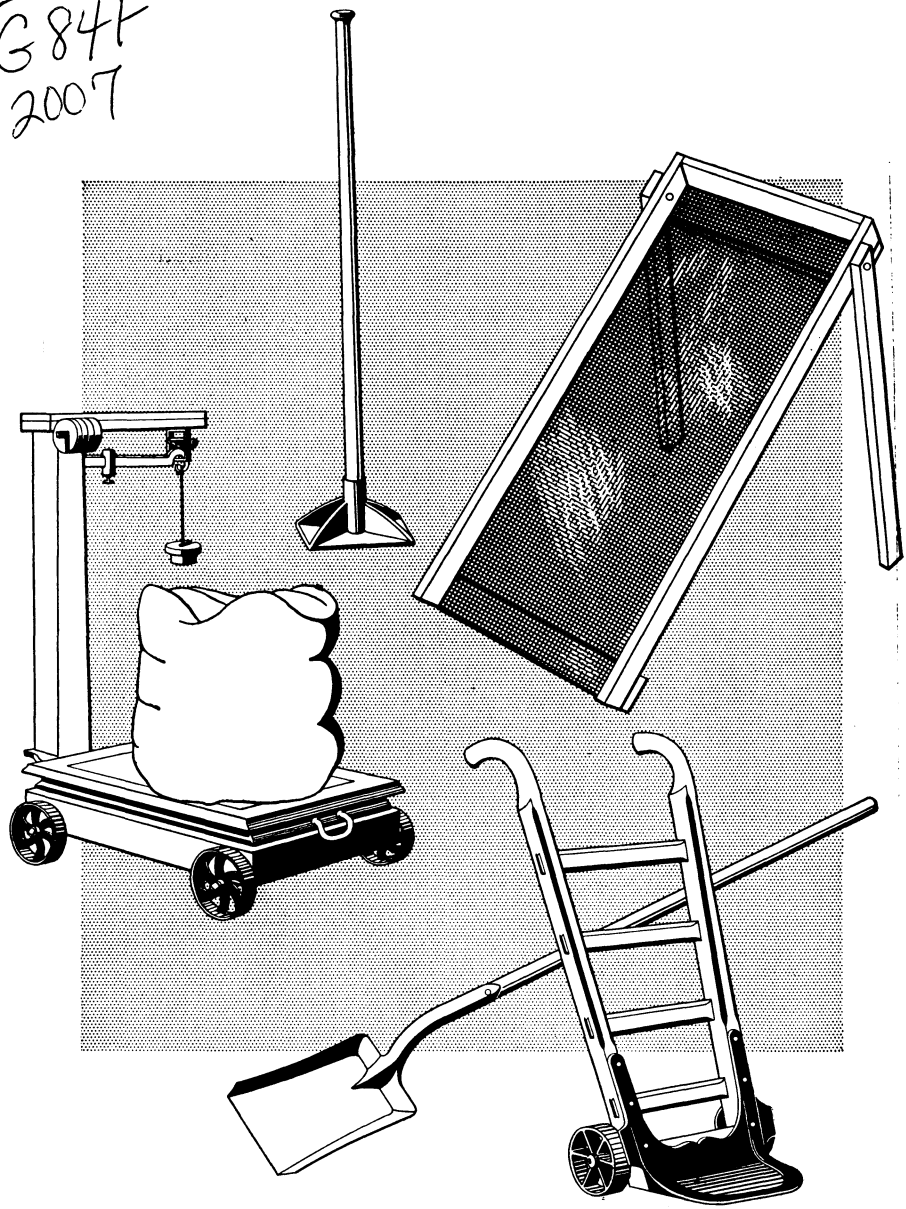
MIXING FERTILIZERS
ON THE FARM



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MANY FARMERS have expressed the desire to make their own mixed fertilizers. It is not difficult to mix fertilizer materials on the farm, and, under some circumstances, home mixing may be more economical than the purchase of factory-made mixtures. It has an educational value, since it serves as an incentive toward acquiring a knowledge of different fertilizer materials and their agricultural values. It encourages experimentation to ascertain what mixtures are best adapted to particular soils and crops. This bulletin explains the amounts and kinds of different fertilizer materials to use to obtain the needed quantities of plant food, outlines the necessary precautions, provides instructions for making the mixtures, and gives other information to assist the home mixer.

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MIXING FERTILIZERS ON THE FARM

By

Colin W. Whittaker

Chemist, Division of Fertilizer and Agricultural Lime, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration

Contents

FERTILIZERS are applied to the soil to increase crop yields and to improve the quality of crops. The amount of fertilizer to use and its best composition with respect to plant foods are determined by the requirements of the crop, by the supplies in the soil of the various plant foods in forms available to plants, and by the nature of the soil. The plant foods it is most frequently necessary to apply are nitrogen, phosphoric acid, and potash. These are known as the primary plant foods.

Calcium, magnesium, and sulfur are known as the secondary plant-food elements. They are usually less deficient in the soil than the primary plant foods, and large quantities of these secondary elements, especially calcium and sulfur, are supplied from sources other than commercial fertilizers or are incidentally present in materials used to supply the primary plant foods. Except for occasional situations where the supply of magnesium is inadequate, usually it is not necessary to include secondary plant foods as such in the fertilizer.

Growing plants may also require small quantities of iron, manganese, boron, chlorine, zinc, copper, and possibly other elements. These elements are variously known as trace, micro, or minor elements. In most areas adequate supplies of these elements are available in the soil, but it is sometimes necessary to apply one or more of them to obtain good yields of high-quality crops. One or more of these elements may be included in the fertilizer.

The major fertilizer problem in much of the crop-producing area of the United States, however, is to furnish adequate supplies of the primary plant foods—phosphoric acid, nitrogen, and potash. Where only one of these is not adequately available in the soil a single plant-

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food carrier, or unmixed fertilizer material, that supplies the needed plant food may be applied directly. Sodium nitrate, for example, may be applied to supply nitrogen, superphosphate to supply phosphoric acid, or potassium chloride to supply potash. More commonly it is necessary to apply two, or all three, of these primary plant foods, and for this purpose it is economical and convenient to use mixtures of materials that supply the ones needed. The use of such mixed fertilizers makes it possible to complete the fertilizing job in one operation where two or more trips over the land would be required if the materials were used unmixed.

WHEN HOME MIXING IS DESIRABLE

Mixed fertilizers are usually purchased ready for use, but the mixing may be done on the farm. If commercial mixtures suitable for local soil and crop conditions are available at reasonable prices it will usually be more convenient, and often more economical, to buy and use the commercial products. The farmer is protected in the purchase of commercial fertilizers by laws that require guarantees of the plant-food content. All the States have such laws.

Some farmers, nevertheless, may find it desirable to prepare fertilizer mixtures on the farm. Determining factors may be the need for a particular type of fertilizer not commercially available, local price and supply situations, and the need for utilizing farm labor during slack periods. Experience in home mixing will enable the farmer to learn the nature of mixed fertilizers and the agricultural value of the different fertilizer materials as related to his farm. With such experience, he can experiment to determine what mixtures are best for his purposes or duplicate mixtures that have proved especially effective. The relative costs and other advantages of commercial and home-mixed fertilizers should, however, be carefully considered before undertaking home mixing.

PURCHASING FERTILIZER MATERIALS

When purchasing fertilizer materials, prices should be obtained not only from local dealers but from other firms as well. Lists of firms may be obtained from the State officials enforcing the fertilizer laws, from the State agricultural experiment station, or from the United States Department of Agriculture. The farmer should seek the advice of his county agent. Better prices are often obtained by buying in large quantity, paying cash, and purchasing well in advance.

The plant foods—nitrogen, phosphoric acid, and potash—cost more in some materials than in others, and it is frequently possible to save money through a wise choice of materials. In purchasing phosphates, for example, the buyer should be interested in the cost of the available phosphoric acid that the phosphate contains rather than in the cost per ton of the material. Superphosphate containing 20 percent of phosphoric acid has 400 pounds of phosphoric acid in each ton. If the ton costs $30 this phosphoric acid will cost the farmer 7.5 cents a pound. Double superphosphate containing 45 percent of phosphoric acid has 900 pounds of phosphoric acid in each ton. If the cost per ton is $55, a pound of phosphoric acid in this material will cost only

6.1 cents despite the higher cost per ton of phosphate. The double superphosphate in this case would be the better buy. These prices are used as an illustration only and may not correspond to actual prices in any locality.

Phosphoric acid usually gives about equally good results whether derived from superphosphate, double superphosphate, ammonium phosphate, or other processed phosphate material. For most crops potash is about equally effective whether applied as potassium chloride, potassium sulfate, sulfate of potash-magnesia, or in other soluble form. Potassium sulfate is preferred for some crops, for example, tobacco. Sulfate of potash-magnesia is a desirable form of potash where the soil is low in available magnesium.

Nitrogen for most crops is about equally effective whether applied as ammonium sulfate, ammonium nitrate, sodium nitrate, or in other inorganic material. The organic forms of nitrogen—fish scrap, cottonseed meal, dried blood, and others—are often preferred to the inorganic forms for some crops. Organic nitrogen, however, is usually much more expensive than the inorganic forms. The farmer should consult his county agent or State agricultural experiment station to determine if, under his conditions, any advantage gained from the use of organic nitrogen will justify the additional cost.

Materials suitable for home mixing are listed in table 1. Not all of the materials will be available in any particular locality, but as many

TABLE 1.—*Approximate composition of principal fertilizer materials suitable for home mixing*

Material supplying—	Nitrogen	Phosphoric acid	Potash
Nitrogen:	*Percent*	*Percent*	*Percent*
Ammonium nitrate	33. 0		
Ammonium sulfate (sulfate of ammonia)	20. 5		
Sodium nitrate (nitrate of soda)	16. 0		
Cal-Nitro (A-N-L)	20. 5		
Calcium cyanamide (Cyanamid)	22. 0		
Urea (uramon)	42. 0		
Dried blood (blood meal)	13. 0	2. 0	1. 0
Tankage (animal tankage)	7. 0	10. 0	. 5
Fish scrap (dried)	6. 0–10. 0	6. 0	
Cottonseed meal	5. 7– 6. 6	2. 5	1. 5
Castor pomace	6. 0	1. 5	. 5
Phosphoric acid:			
Superphosphate		18. 0–22. 0	
Double (treble, triple) superphosphate		43. 0–49. 0	
Ammonium phosphate	11. 0	48. 0	
Ammonium phosphate-sulfate	16. 0	20. 0	
Bonemeal	1. 5– 4. 0	20. 0–30. 0	
Potash:			
Potassium chloride (muriate of potash)			50. 0–60. 0
Potassium sulfate (sulfate of potash)			48. 0–52. 0
Sulfate of potash-magnesia [1]			21. 0–26. 0
Manure salts			25. 0–30. 0
Tobacco stems	2. 0	. 5	6. 0

[1] Contains 18.5 percent of magnesium oxide (11.2 percent of magnesium).

of them can be used interchangeably, the home mixer should be able to select and obtain materials that will be satisfactory for the mixtures desired.

Some of the materials listed in table 1, as cottonseed meal, bonemeal, dried blood, fish scrap, and tankage, when properly prepared and handled, are also excellent stock feeds. Many of the other materials, however, may be harmful to both stock and human beings if eaten or inhaled. Castor pomace, for example, is definitely toxic. It is best to keep stock away from all fertilizers, both to protect the stock and to avoid wastage of the materials. Care should also be taken not to inhale too much dust from fertilizers. When large quantities of fertilizers are mixed indoors, full-face respirators should be worn.

PLANNING THE MIXTURE

Commercially mixed fertilizers contain definite percentages of the primary plant foods. A 4–12–8 mixed fertilizer contains 4 percent of nitrogen (N), 12 percent of phosphoric acid (P_2O_5), and 8 percent of potash (K_2O). The purpose of any application of fertilizer is to put the required amounts of the plant foods within reach of the plant. To do this the home mixer may prepare and apply (1) a mixture that is the equivalent of some commercial grade, but does not necessarily contain exactly the same percentage of plant food; (2) a mixture having exactly the percentages of plant food in the commercial grade; or (3) one that supplies the quantities of plant foods known to be needed without attempting to imitate any particular grade.

Let us suppose that a farmer wishes to make a mixture equivalent to a ton of commercial 4–12–8 fertilizer. A ton of this grade contains 80 pounds of nitrogen (4 percent of a ton), 240 pounds of phosphoric acid, and 160 pounds of potash. Various combinations of the materials listed in table 1 can be used to supply these amounts of plant food. The following three mixtures all contain the same quantities of the primary plant foods as are contained in a ton of 4–12–8.

	Pounds
Mixture No. 1:	
Ammonium sulfate (20.5 percent N)	390
Superphosphate (20.0 percent P_2O_5)	1, 200
Potassium chloride (60.0 percent K_2O)	267
Total	1, 857
Mixture No. 2:	
Cal-Nitro (20.5 percent N)	195
Ammonium sulfate (20.5 percent N)	195
Double superphosphate (45 percent P_2O_5)	533
Potassium sulfate (50.0 percent K_2O)	320
Total	1, 243
Mixture No. 3:	
Ammonium nitrate (33.0 percent N)	61
Ammonium sulfate (20.5 percent N)	98
Cottonseed meal (6.0 percent N)	667
Superphosphate (20.0 percent P_2O_5)	1, 200
Sulfate of potash-magnesia (25.0 percent K_2O)	640
Total	2, 666

The amounts of materials to use to obtain the needed quantities of the plant foods are computed in a simple manner. In the example

used, 80 pounds of nitrogen are needed. If this is all to be supplied as ammonium sulfate containing 20.5 percent of nitrogen as in mixture 1, the required amount is obtained as follows:

$$\frac{80}{20.5}\times 100=390 \text{ pounds.}$$

In mixture 2, 40 pounds of nitrogen was derived from Cal-Nitro and 40 from ammonium sulfate. The required amount of either is given by:

$$\frac{40}{20.5}\times 100=195 \text{ pounds.}$$

Together they make up the required 80 pounds of nitrogen. The amount of cottonseed meal to supply 40 pounds of nitrogen as in mixture 3 is given by:

$$\frac{40}{6.0}\times 100=667 \text{ pounds.}$$

If potassium chloride (60.0 percent K_2O) is used to supply the required 160 pounds of potash as in mixture 1, the amount is:

$$\frac{160}{60.0}\times 100=267 \text{ pounds.}$$

If superphosphate (20.0 percent P_2O_5) is used to supply the required 240 pounds of phosphoric acid, the amount required is:

$$\frac{240}{20.0}\times 100=1{,}200 \text{ pounds.}$$

The amounts of the other materials are computed in the same manner.

Some fertilizer materials contain two plant foods. Ammonium phosphate-sulfate, for example, contains 16 percent of nitrogen in addition to 20 percent of phosphoric acid. One hundred pounds of this material will supply 20 pounds of phosphoric acid and 16 pounds of nitrogen. The quantity of ammonium sulfate or other nitrogen material needed to make up the balance of nitrogen required will be correspondingly less in mixtures where ammonium phosphate-sulfate has been used to supply phosphoric acid.

Instead of computing the amounts, the home mixer may read the required quantities directly from table 2. In making mixture 1, for example, the amount (390 pounds) of ammonium sulfate (20.5 percent nitrogen) required to furnish the amount of nitrogen in the 4–12–8 fertilizer is found in the column headed 80 pounds, opposite ammonium sulfate. Since the table does not read as high as 240 pounds, the quantity of superphosphate (20.0 percent P_2O_5) is found by adding the amount in the column headed 200 pounds to that in the column headed 40 pounds to give the required 1,200 pounds. The quantity of potassium chloride (60.0 percent K_2O) is found in the 160 pounds column to be 267 pounds.

TABLE 2.—*Quantities of fertilizer materials to be used to supply definite amounts of plant foods*

Material supplying—	Pounds of plant food desired									
	20	40	60	80	100	120	140	160	180	200
	Pounds required	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*	*Pounds required*
Nitrogen (N):										
Ammonium nitrate (33.0 percent N)	61	121	182	242	303	364	424	485	545	606
Ammonium sulfate (20.5 percent N)	98	195	293	390	488	585	683	780	878	976
Sodium nitrate (16.0 percent N)	125	250	375	500	625	750	875	1, 000	1, 125	1, 250
Cal-Nitro (20.5 percent N)	98	195	293	390	488	585	683	780	878	976
Calcium cyanamide (22.0 percent N)	91	182	273	364	455	545	636	727	818	909
Urea (42 percent N)	48	95	143	190	238	286	333	381	429	476
Dried blood (13.0 percent N) [1]	154	308	462	615	769	923	1, 077	1, 231	1, 385	1, 538
Tankage (7.0 percent N) [1]	286	571	857	1, 142	1, 429	1, 714	2, 000			
Fish scrap (8.0 percent N) [1]	250	500	750	1, 000	1, 250	1, 500	1, 750	2, 000		
Cottonseed meal (6.0 percent N) [1]	333	667	1, 000	1, 333	1, 667	2, 000				
Castor pomace (6.0 percent N) [1]	333	667	1, 000	1, 333	1, 667	2, 000				
Phosphoric acid (P_2O_5):										
Superphosphate (20.0 percent P_2O_5)	100	200	300	400	500	600	700	800	900	1, 000
Double superphosphate (45.0 percent P_2O_5)	44	89	133	178	222	267	311	356	400	444
Ammonium phosphate (48.0 percent P_2O_5) [2]	42	83	125	167	208	250	292	333	375	417
Ammonium phosphate-sulfate (20.0 percent P_2O_5) [2]	100	200	300	400	500	600	700	800	900	1, 000
Bonemeal (25.0 percent P_2O_5)	80	160	240	320	400	480	560	640	720	800
Potash (K_2O):										
Potassium chloride (60.0 percent K_2O)	33	67	100	133	167	200	233	267	300	333
Potassium sulfate (50.0 percent K_2O)	40	80	120	160	200	240	280	320	360	400
Sulfate of potash-magnesia (25.0 percent K_2O) [3]	80	160	240	320	400	480	560	640	720	800
Manure salts (25.0 percent K_2O)	80	160	240	320	400	480	560	640	720	800
Tobacco stems (6.0 percent K_2O) [2]	333	667	1, 000	1, 333	1, 667	2, 000				

[1] Also supplies phosphoric acid. See table 1.
[2] Also supplies nitrogen. See table 1.
[3] Also supplies magnesium. See footnote to table 1.

The analysis of materials actually purchased may differ from those used in computing table 2. Sulfate of potash-magnesia, for example, may contain 21.0 percent potash instead of 25.0 percent. The home mixer may also wish to use materials not given in the table. In such cases it will be necessary to compute the amounts as explained above. Small variations in analysis, as ammonium nitrate containing 32.5 percent of nitrogen instead of 33.0 percent, can be ignored, as such small differences will have no appreciable effect on the results.

Smaller or larger batches are readily figured. To make a mixture equivalent to 500 pounds of any grade take one-fourth of the amounts necessary to make a mixture equivalent to a ton of that grade. If the equivalent of 2 tons is required double the amounts, and so on.

None of the three mixtures (p. 4) come out exactly to a ton, but this can be compensated for by adjusting the fertilizer distributor. The application of 1,857 pounds of mixture No. 1, 1,243 pounds of mixture No. 2, or 2,666 pounds of mixture No. 3 will be equivalent to applying a ton of 4–12–8. In the use of mixture No. 2, the farmer will need to handle only slightly more than half the weight of material or the number of bags that he would have to handle if using the commercial 4–12–8 grade.

If 500 pounds per acre of 4–12–8 has been used and it is desired to use an equivalent amount of mixture No. 1, compute the amount as follows:

$$500\times\frac{1{,}857}{2{,}000}=464 \text{ pounds.}$$

For mixture No. 3 the calculation is:

$$500\times\frac{2{,}666}{2{,}000}=667 \text{ pounds.}$$

Home mixtures equivalent to other commercial grades as 8–12–6, 5–10–5, and so on, may be formulated in the same manner.

The home mixer may readily make mixtures containing the same percentages of plant foods as the commercial grades. This has the advantage that such mixtures can be applied at the same rate as the corresponding commercial ones, but it involves extra figuring and usually additional materials.

Mixture No. 1 now totals 1,857 pounds. By adding 143 pounds of some material that contains no primary plant food the mixture will total 2,000 pounds and will have the same percentages of plant foods as the 4–12–8. Sand or dry soil could be used, but it is preferable to add something that is of some value in itself. Using 143 pounds of finely ground dolomite would make the mixture less acid-forming (see p. 10) and reduce the tendency to cake. Peanut-hull meal or other of the conditioners discussed later could also be used. Many of these contain small quantities of nitrogen that become of some value as the material decomposes in the soil. Other mixtures that add to less than the ton formula can be similarly treated.

Mixtures like No. 3, where the quantities of materials already add to more than a ton, can only be made exactly to the grade by a different choice of materials. Double superphosphate containing 45 percent of P_2O_5, for example, may be substituted for the superphos-

phate, and potassium sulfate containing 50 percent of potash for the sulfate of potash-magnesia. The revised formula is as follows:

Mixture:	*Pounds*
Ammonium nitrate (33.0 percent N)	61
Ammonium sulfate (20.5 percent N)	98
Cottonseed meal (6.0 percent N)	667
Double superphosphate (45 percent P_2O_5)	533
Potassium sulfate (50.0 percent K_2O)	320
Total	1, 679

Since the cottonseed meal will condition this mixture one might add 147 pounds of ground dolomitic limestone to make the mixture non-acid-forming, plus 174 pounds of sand, dry soil, or other low-cost material to make up the needed 321 pounds. Alternately, one might add simply 321 pounds of the dolomitic limestone. The mixture will then be of the 4–12–8 grade.

On the other hand if the farmer has been advised that he needs, for example, 60 pounds of nitrogen, 200 of phosphoric acid, and 100 of potash per acre, he may make a mixture that will supply these quantities of plant foods without thought of achieving any particular grade. Simply select the materials and compute, as on page 5, the quantities required to give the needed plant foods. Table 2 may be used for this purpose also. If ammonium sulfate, superphosphate, and sulfate of potash-magnesia are to be used, the table gives directly 293 pounds of ammonium sulfate, 1,000 of superphosphate, and 400 of sulfate of potash-magnesia.

MIXTURES CONTAINING SECONDARY AND MINOR PLANT FOODS

Various secondary and minor plant-food elements may be included in the home-mixed fertilizer. The home mixer should not, however, include such elements unless he knows definitely which element or elements are needed and in what amount. An overdose of some of the minor elements, especially boron, manganese, copper, or zinc, may be worse than too little of these elements, resulting in injury to the plants. When used in the proper amounts, these elements are valuable plant foods, but in even slight excess they may be definite poisons. The advice of the county agent or State agricultural experiment station should always be sought before including such elements in the home-mixed fertilizer.

Magnesium, boron, manganese, copper, and zinc are the principal minor elements that the home mixer may wish to include in his mixture. Dolomitic limestone is a good source of magnesium. If the land has been limed with dolomitic limestone or if this material has been used in the mixture, there will seldom be any need to add other magnesium. In some situations a more quickly available form of magnesium may be desired. Materials that may be used to supply quickly available magnesium and minor elements are listed below:

Material:	*Element*
Magnesium sulfate:	
Epsom salts	11–13 percent magnesium
Calcined kieserite	17–19 percent magnesium
Borax	11 percent boron
Copper sulfate (bluestone)	25 percent copper
Manganese sulfate	Variable, use manufacturer's analysis

Quickly available magnesium may also be supplied by using potash in the form of sulfate of potash-magnesia.

PRECAUTIONS

Many mixtures must be used within a few days after mixing if caking and dampness are to be avoided. Some fertilizer materials, moreover, are incompatible with others and should not be mixed with them. Materials known as conditioners may be added to reduce the tendencies to cake or become moist. Various kinds of organic residues are good conditioners if finely ground and dry. Some inorganic materials are also effective. Manufacturers use many different things, including meals made from peanut, tung nut, and rice hulls and soybean residues. Powdered dry peat, cork dust, and spent fuller's earth are other examples. All of these are suitable for use in home mixing but may be difficult to obtain at reasonable cost.

The farmer may substitute various organic residues available on most farms, such as well-rotted manure, compost, or leaves or other organic residues or even loamy soil. Whatever the nature of the material it must be thoroughly dry and finely ground. Often such materials can be broken up sufficiently by forcing them through a one-fourth-inch mesh screen. If the mixture is to be stored before use about 200 pounds of conditioner should be included in each ton. Even this will not entirely prevent caking in mixtures like No. 1 (p. 4) that contain large proportions of both ammonium sulfate and superphosphate. Preparation of the mixture immediately before use largely avoids the need for conditioner.

Mixtures that contain large proportions of organic nitrogen materials, as cottonseed meal, castor pomace, dried blood, tankage, or fish scrap, are usually sufficiently conditioned by these materials and will not cake seriously.

Because of undesirable chemical reactions that may occur, calcium cyanamide (Cyanamid) should not be mixed directly with ammonium sulfate, ammonium phosphate, or ammonium nitrate. Not more than about 75 pounds of Cyanamid should be used for each 1,000 pounds of superphosphate in mixtures.

Ammonium nitrate tends to absorb moisture and become sticky, and, when carelessly handled on the farm, its presence may constitute a fire and explosion hazard. It is usually sold, however, in moisture-resistant bags that effectively protect it against moisture absorption. The bags should be stored in a dry place and if once opened should be tightly reclosed unless fully emptied. The contents of torn bags should be promptly rebagged. All spilled ammonium nitrate should be cleaned up promptly; if allowed to lie about on the bags in humid weather, it will absorb moisture, which will weaken the bags and result in further spillage when the bags are moved.

No farmer handling or storing ammonium nitrate need fear fires or explosions if the following safety rules are observed.

1. Do not smoke or permit smoking or the use of open flames in or near space where ammonium nitrate is stored.

2. Keep ammonium nitrate away from steam pipes and electric wiring and away from combustible materials of all

kinds, especially gasoline, oils, sulfur, paints, straw, hay, cloth, paper, and shavings.

3. Store ammonium nitrate in a well-ventilated building to permit escape of gases in the event of fire. Large quantities to be stored for a considerable period should be placed in a building several hundred feet removed from other farm buildings.

4. Clean up spilled ammonium nitrate and discard if it has become mixed with combustible material or apply to the soil immediately. Do not return such contaminated material to the bag.

5. Destroy promptly empty bags that have contained ammonium nitrate. Such bags are highly inflammable.

Sodium nitrate, although less hazardous than ammonium nitrate, should not be handled carelessly. Like ammonium nitrate, it should be kept away from combustible materials and cleaned up promptly when spilled, and empty bags that have contained sodium nitrate should be promptly destroyed.

Large proportions of ammonium nitrate in a mixture may cause the mixture to become damp on standing and, if organic matter is present, may constitute a fire hazard. For both these reasons not more than about 200 pounds of ammonium nitrate should be used in each ton of mixture for immediate use and not more than about 100 pounds if the mixture must be prepared more than a few days prior to use in the field. Wherever possible it is best to use mixtures containing ammonium nitrate immediately after mixing. The inclusion of a conditioner helps to avoid dampness and is usually desirable in mixtures containing ammonium nitrate. Dampness is more effectively avoided by the use of moisture-resistant bags of the type in which the ammonium nitrate was purchased. Such bags are commonly made of several plies of heavy kraft paper, one or more of which is asphalt-laminated to keep out moisture. The bags must be tightly closed after filling and be free from holes.

AVOIDING BAG ROT

Most mixed fertilizers tend to rot the bags in which they are stored. Mixtures containing Cyanamid or dolomitic limestone will, in general, not rot bags as rapidly as those that do not contain these substances. In mixtures containing neither Cyanamid nor dolomitic limestone, bag rotting can be reduced by the inclusion in the mixture of about 20 pounds of quicklime or 30 pounds of hydrated lime for each 1,000 pounds of superphosphate. More lime than this should not be used, as it tends to reduce the availability of the phosphoric acid and may cause loss of nitrogen from the mixture.

MAKING MIXTURES NON-ACID-FORMING

Some fertilizers, especially those containing large proportions of urea, ammonium sulfate, or other ammonium salts, tend to make the soil more acid. While this is not generally serious, especially where the soil is limed as needed, the home mixer may wish to avoid it. Mixed fertilizers can be made non-acid-forming by including in the mixture sufficient finely ground dolomitic limestone (do not use high-

calcium limestone) to overcome the acid-forming tendencies of other ingredients. The dolomitic limestone will also supply magnesium to the plants. The amounts to use for each 10 pounds of acid-forming material are:

Acid-forming material (10 pounds):	*Pounds of limestone*
Ammonium sulfate	11. 0
Ammonium nitrate	6. 4
Ammonium phosphate	5. 9
Ammonium phosphate-sulfate	8. 8
Urea	8. 0

If a mixture contains, for example, 200 pounds of ammonium sulfate and no other acid-forming material, 220 pounds of the dolomitic limestone are required to make it non-acid-forming.

Some fertilizer materials, especially sodium nitrate and Cyanamid, have the opposite effect: they tend to make the soil less acid. Consequently, when these are used in conjunction with acid-forming materials less dolomitic limestone is needed. From the total requirement deduct 6.2 pounds for each 10 pounds of Cyanamid or 2.9 pounds for each 10 pounds of sodium nitrate. If the mixture containing 200 pounds of ammonium sulfate, mentioned in the preceding paragraph, also contained 100 pounds of sodium nitrate, it would require 29 pounds less dolomitic limestone, or 191 pounds altogether. It is not necessary to be exact, as excess dolomitic limestone over that required will do no harm and too little may simply mean that the mixture will be acid-forming to an unimportant extent.

MIXING FERTILIZER MATERIALS

In making any mixed fertilizer the various ingredients must be very thoroughly mixed. If the mixing is poorly done some plants may receive too little of nitrogen, for example, while getting more phosphoric acid and potash than is needed. This results in uneven growth of the crop and reduced yields. Good home mixing is perhaps most easily done with a small concrete mixer of the rotary-tilting type, but can also be done satisfactorily by hand. Special precautions, to be discussed later, are necessary if minor elements are to be included in the mixture.

If the materials are lumpy or caked, break up the lumps with the back of a shovel or with a tamper until all the material will pass through a screen having about ¼-inch, or smaller, openings. A convenient screen is one about 3 by 5 feet in size that can be set up in a tilted position so that the material can be shoveled onto it and allowed to flow down the screen (fig. 1).

If the mixer is to be used, weigh out the lump-free materials in such amount that the mixer will not be overloaded and mix in the machine for about 5 minutes. A preliminary trial should be made to determine the proper-sized batch. The product should then be ready for immediate use or for bagging for later use. Overloading of the mixer will result in poor mixing and spilling of the materials. If a ton formula has been computed, it will usually be convenient to take some fraction of the amounts figured, as one-tenth or one-twentieth, depending on the size of the mixer. Exact weighing of the materials for each filling of the mixer is not necessary, as small variations in the

FIGURE 1.—Mixing the materials.

proportions of the materials will make little difference in the results. Buckets or other suitable vessels containing the correctly weighed quantities of each material to be used can be marked on the inside and afterward filled to the mark without weighing. It is best to mark the vessel for each material because some materials are more bulky than others.

Hand mixing has the advantage that larger batches can be handled than the average small mixer will accommodate. Weigh out the required quantity of the most bulky material, usually the superphosphate, and place it in a long narrow, flat-topped pile on a clean, tight floor. Spread the required weights of each of the other materials over the full length of the pile. Beginning at one end, shovel into a new pile, spreading each shovelful over the face of the heap. Then form the new pile into a long narrow shape at right angles to the original pile and proceed as before. Continue for one complete shoveling after all streaks of color have disappeared. Clean the floor and tools as soon as the work is completed. Hand mixing, carefully done, is as effective as mixing by machine.

MIXING IN MINOR ELEMENT MATERIALS

Because of the possible toxic effects of an overdose, it is necessary that materials furnishing minor elements be very thoroughly mixed with the other fertilizer ingredients to insure that no plant receives too much. This is difficult because of the small amounts of such materials used. Often this will be only a few pounds per ton of mixture. Thorough mixing of such materials, borax for example, with the other fertilizer ingredients can be accomplished if they are

finely powdered and thoroughly premixed with one of the less bulky of the main ingredients, as potassium chloride or finely ground dolomitic limestone. This premixture is then mixed with the other ingredients in the usual way.

ADVANTAGES OF HOME MIXING

Mixing fertilizers on the farm brings home to the farmer the importance of the various plant foods and familiarizes him with the materials from which they may be obtained. It may enable him to fertilize his crops in a more effective manner than he could by using commercial fertilizers. In places where the materials can be purchased at sufficiently low prices and where the farmer has the labor and equipment to do his own mixing, a good profit may be shown from home mixing.

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